

WHAT IS CLAIMED IS:

1. An anti-fog coating composition comprising a silicone compound free from a sulfonic acid functional group, a water dispersible polyurethane compound, and water.

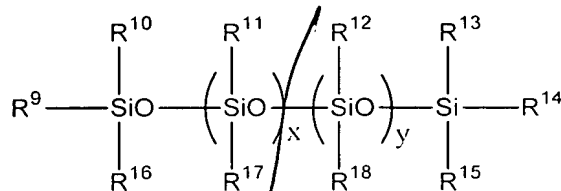
2. The anti-fog coating composition according to Claim 1, wherein the silicone compound is present in the coating composition at about 0.1 to about 20 weight percent, and wherein the polyurethane compound polymer present in the coating composition is about 5 to about 50 weight percent, based on the total weight of the coating composition.

3. The aqueous coating composition according to Claim 1, wherein the silicone compound is of the formula:



wherein the subscripts a, c, d, e, f, and g are zero or a positive integer, subject to the limitation that the sum of the subscripts b, d, and f is one or greater; M has the formula: $R^1_3 SiO_{1/2}$, wherein each R^1 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; M' has the formula: $R^2_{3-h} R^3_h SiO_{1/2}$, wherein each R^2 and R^3 are independently monovalent hydrocarbon radicals having from one to forty carbon atoms, and the subscript h is 1, 2, or 3; D has the formula: $R^4_2 SiO_{2/2}$, wherein each R^4 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; D' has the formula: $R^5_{2-i} R^6_i SiO_{2/2}$, wherein each of R^5 and R^6 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms, and the subscript i is 1 or 2; T has the formula: $R^7 SiO_{3/2}$, wherein each R^7 is a monovalent hydrocarbon radical having from one to forty carbon atoms; T' has the formula: $R^8 SiO_{3/2}$, wherein R^8 is a monovalent hydrocarbon radical having from one to forty carbon atoms; and Q has the formula: $SiO_{4/2}$.

4. The aqueous coating composition according to Claim 1, wherein the silicone compound is an ionic or nonionic siloxane alkylate of the formula:



wherein each of R^9 through R^{17} are independently a monovalent hydrocarbonyl radical, and R^{18} is $R^{19}-Z-(C_mH_{(2m-1)}R^{20}O)_j(C_nH_{2n}O)_kR^{21}$, wherein m and n are integers greater than or equal to 0; j and k are integers greater than or equal to 0, subject to the proviso that the sum of $j + k$ is greater than or equal to 1; Z is H, -O-, -S-, -SH-, -CO-, -NH-, or -NH₂-; R^{19} is a divalent hydrocarbonylene radical, R^{20} and R^{21} are independently hydrogen, alkyl, hydroxyalkyl, amino, amido, amineoxide, cyano, isocyano, aryl, arylene, carboxy, alkoxy, halogen, haloalkyl, haloalkoxy, sulfo, sulfamo, phosphono, salts thereof, combinations comprising at least one of the foregoing moieties, and wherein x and y are integers greater than or equal to 0, subject to the proviso that $x + y$ is greater than or equal to 1.

5. The coating composition according to Claim 1, further comprising an additive selected from the group comprising a UV absorber, an antistatic agent, pigments, photosensitizing agents, fillers, dyes, fungicidal, bactericidal and antimicrobial agents, antistatic agents, particulates which control the friction or surface contact areas, defoamers, buffers to control pH of the coating compositions, corrosion inhibitors, combinations comprising at least one of the foregoing, and the like.

6. The coating composition according to Claim 1, further comprising a co-solvent selected from the group consisting of N-methyl pyrrolidone, glycol ether, isopropanol, and combinations comprising at least one of the foregoing co-solvents.

7. The coating composition according to Claim 1, wherein the silicone compound is chemically bound to the polyurethane compound.

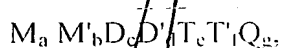
8. The coating composition according to Claim 6, wherein the co-solvent present in the coating composition is about 5 to about 10 weight percent, based on the total weight of the coating composition.

9. A process for forming an anti-fog film on a substrate comprising

applying an aqueous coating composition to the substrate, wherein the aqueous coating composition comprises a silicone compound free from a sulfonic acid group, a water dispersible polyurethane compound, and water; and

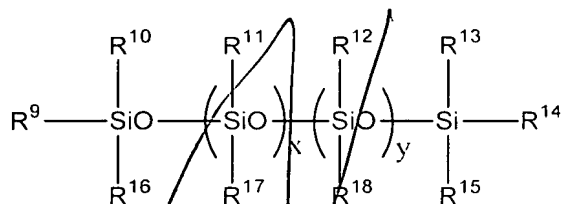
coalescing the silicone compound and polyurethane compound to form a film on the substrate.

10. The process according to Claim 9, wherein the silicone compound comprises the formula:



wherein the subscripts a, c, d, e, f, and g are zero or a positive integer, subject to the limitation that the sum of the subscripts b, d, and f is one or greater; M has the formula: $R^1_3 SiO_{1/2}$, wherein each R^1 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; M' has the formula: $R^2_{3-h} R^3_h SiO_{1/2}$, wherein each R^2 and R^3 are independently monovalent hydrocarbon radicals having from one to forty carbon atoms, and the subscript h is 1, 2, or 3; D has the formula: $R^4_2 SiO_{2/2}$, wherein each R^4 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; D' has the formula: $R^5_{2-i} R^6_i SiO_{2/2}$, wherein each of R^5 and R^6 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms, and the subscript i is 1 or 2; T has the formula: $R^7 SiO_{3/2}$, wherein each R^7 is a monovalent hydrocarbon radical having from one to forty carbon atoms; T' has the formula: $R^8 SiO_{3/2}$, wherein R^8 is a monovalent hydrocarbon radical having from one to forty carbon atoms; and Q has the formula: $SiO_{4/2}$.

11. The process according to Claim 9, wherein the silicone compound is an ionic or nonionic siloxane alkoylate of the formula:



wherein each of R^{9-17} are independently a monovalent hydrocarbonyl radical, R^{18} is of the general formula: $R^{19}-Z-(C_mH_{2m-1}R^{20}O)_j(C_nH_{2n}O)_kR^{21}$, m and n are integers greater than or equal to 0; j and k are integers greater than or equal to 0, subject to the proviso that the sum of $j+k$ is greater than or equal to 1; Z is H, -O-, -S-, -SH-, -CO-, -NH-, or -NH₂-; R^{19} is a divalent hydrocarbonylene radical, R^{20} and R^{21} are independently hydrogen, alkyl, hydroxyalkyl, amino, amido, amineoxide, cyano, isocyano, aryl, arylene, carboxy, alkoxy, halogen, haloalkyl, haloalkoxy, sulfo, sulfamo, phosphono, salts thereof, combinations comprising at least one of the foregoing, and the like; and wherein x and y are integers greater than or equal to 0, subject to the proviso that $x+y$ is greater than or equal to 1.

12. The process according to Claim 9, further comprising heating the substrate to a temperature of about 20°C to about 150°C.

13. The process according to Claim 9, wherein the substrate comprises a polyester, a cellulose ester, a polycarbonate, a polystyrene, a polyvinyl acetate, a polyolefin, and combinations comprising at least one of the foregoing.

14. The process according to Claim 9, wherein the aqueous coating composition further comprises a co-solvent selected from the group consisting of N-methyl pyrrolidone, glycol ether, isopropanol, and combinations comprising at least one of the foregoing co-solvents.

15. The process according to Claim 9, wherein the silicone compound is chemically bound to the polyurethane compound.

16. The process according to Claim 14, wherein the co-solvent is about 5 to about 10 weight percent of the coating composition.

17. A glass or plastic article having an anti-fogging surface comprising:

a glass or plastic substrate; and

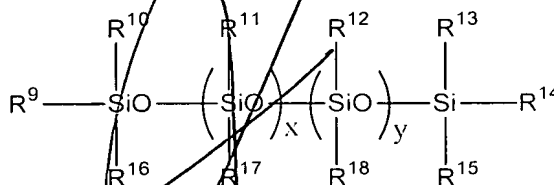
an anti-fog coating disposed on at least one surface of the substrate, the anti-fog coating comprising a silicone compound free of a sulfonic acid function group, a water dispersible polyurethane compound, and water.

18. The glass or plastic article of Claim 17, wherein the silicone compound is of the formula:



wherein the subscripts a, c, d, e, f, and g are zero or a positive integer, subject to the limitation that the sum of the subscripts b, d, and f is one or greater; M has the formula: $R^1_3 SiO_{1/2}$, wherein each R^1 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; M' has the formula: $R^2_{3-h} R^3_h SiO_{1/2}$, wherein each R^2 and R^3 are independently monovalent hydrocarbon radicals having from one to forty carbon atoms, and the subscript h is 1, 2, or 3; D has the formula: $R^4_2 SiO_{2/2}$, wherein each R^4 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; D' has the formula: $R^5_{2-i} R^6_i SiO_{2/2}$, wherein each of R^5 and R^6 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms, and the subscript i is 1 or 2; T has the formula: $R^7 SiO_{3/2}$, wherein each R^7 is a monovalent hydrocarbon radical having from one to forty carbon atoms; T' has the formula: $R^8 SiO_{3/2}$, wherein R^8 is a monovalent hydrocarbon radical having from one to forty carbon atoms; and Q has the formula: $SiO_{4/2}$.

19. The glass or plastic article of Claim 17, wherein the silicone compound is an ionic or nonionic siloxane alkoxide of the formula:



wherein each of R^{9-17} are independently a monovalent hydrocarbonyl radical, R^{18} is of the general formula: $R^{19}-Z-(C_m H_{(2m-1)}) R^{20} O)_j (C_n H_{2n} O)_k R^{21}$, m and n are integers

greater than or equal to 0; j and k are integers greater than or equal to 0, subject to the proviso that the sum of j+k is greater than or equal to 1; Z is H, -O-, -S-, -SH-, -CO-, -NH-, or -NH₂-; R¹⁹ is a divalent hydrocarbylene radical, R²⁰ and R²¹ are independently hydrogen, alkyl, hydroxyalkyl, amino, amido, amineoxide, cyano, isocyano, aryl, arylene, carboxy, alkoxy, halogen, haloalkyl, haloalkoxy, sulfo, sulfamo, phosphono, salts thereof, combinations comprising at least one of the foregoing, and the like; and wherein x and y are integers greater than or equal to 0, subject to the proviso that x + y is greater than or equal to 1.

20. The glass or plastic article of Claim 17, wherein the plastic substrate comprises a material selected from the group of polycarbonate, cellulose esters, polystyrene, polyvinyl acetate, polyolefins, polyester, and the like.

21. A process for forming an anti-fog film, the process comprising:
applying a coating composition to a substrate, wherein the coating composition comprises a silicone compound free from a sulfonic acid functional group, an isocyanate, a polyol and a catalyst; and

crosslinking the coating composition to form the anti-fog film, wherein the crosslinking comprises heating the substrate to a temperature and for a time effective to form the film.

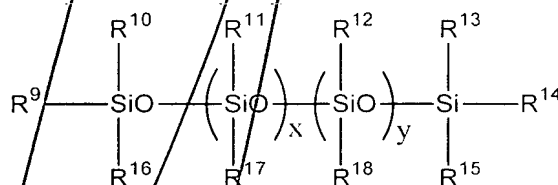
22. The process according to Claim 21, wherein the silicone compound comprises the formula:



wherein the subscripts a, c, d, e, f, and g are zero or a positive integer, subject to the limitation that the sum of the subscripts b, d, and f is one or greater; M has the formula: R¹₃ SiO_{1/2}, wherein each R¹ is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; M' has the formula: R²_{3-h} R³_h SiO_{1/2}, wherein each R² and R³ are independently monovalent hydrocarbon radicals having

from one to forty carbon atoms, and the subscript h is 1, 2, or 3; D has the formula: $R^4_2 SiO_{2/2}$, wherein each R^4 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; D' has the formula: $R^{5,2}R^{6,i}SiO_{2/2}$, wherein each of R^5 and R^6 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms, and the subscript i is 1 or 2; T has the formula: $R^7SiO_{3/2}$, wherein each R^7 is a monovalent hydrocarbon radical having from one to forty carbon atoms; T' has the formula: $R^8SiO_{3/2}$, wherein R^8 is a monovalent hydrocarbon radical having from one to forty carbon atoms; and Q has the formula: $SiO_{4/2}$.

23. The process according to Claim 21, wherein the silicone compound is an ionic or nonionic siloxane alkoylate of the formula:



wherein each of R^{9-17} are independently a monovalent hydrocarbonyl radical, R^{18} is of the general formula: $R^{19}-Z-(C_mH_{(2m-1)}R^{20}O)_j(C_nH_{2n}O)_kR^{21}$, m and n are integers greater than or equal to 0; j and k are integers greater than or equal to 0, subject to the proviso that the sum of j+k is greater than or equal to 1; Z is H, -O-, -S-, -SH-, -CO-, -NH-, or -NH₂-; R^{19} is a divalent hydrocarbyle radical, R^{20} and R^{21} are independently hydrogen, alkyl, hydroxyalkyl, amino, amido, amineoxide, cyano, isocyano, aryl, arylene, carboxy, alkoxy, halogen, haloalkyl, haloalkoxy, sulfo, sulfamo, phophono, salts thereof, combinations comprising at least one of the foregoing, and the like; and wherein x and y are integers greater than or equal to 0, subject to the proviso that x + y is greater than or equal to 1.

24. The process according to Claim 21, wherein crosslinking the coating composition to form the anti-fog film comprises heating the substrate to a temperature of about 20°C to about 150°C.

25. The process according to Claim 21, wherein the substrate comprises a polyester, a cellulose ester, a polycarbonate, a polystyrene, a polyvinyl acetate, a polyolefin, and combinations comprising at least one of the foregoing.

26. The process according to Claim 21, wherein the polyol comprises a polycarbonate polyol.

27. A glass or plastic article having an anti-fogging surface comprising:
a glass or plastic substrate; and

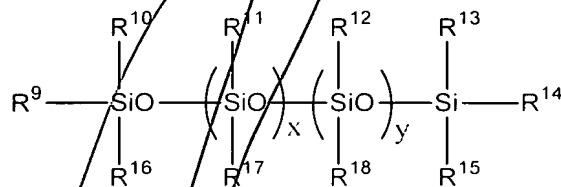
an anti-fog coating disposed on at least one surface of the substrate, the anti-fog coating comprising a crosslinked film formed from a silicone, an isocyanate, a polyol and a catalyst.

28. The glass or plastic article of Claim 27, wherein the silicone compound comprises the formula:



wherein the subscripts a, c, d, e, f, and g are zero or a positive integer, subject to the limitation that the sum of the subscripts b, d, and f is one or greater; M has the formula: $R^1_3 SiO_{1/2}$, wherein each R^1 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; M' has the formula: $R^2_{3-h} R^3_h SiO_{1/2}$, wherein each R^2 and R^3 are independently monovalent hydrocarbon radicals having from one to forty carbon atoms, and the subscript h is 1, 2, or 3; D has the formula: $R^4_2 SiO_{2/2}$, wherein each R^4 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms; D' has the formula: $R^5_{2-i} R^6_i SiO_{2/2}$, wherein each of R^5 and R^6 is independently a monovalent hydrocarbon radical having from one to forty carbon atoms, and the subscript i is 1 or 2; T has the formula: $R^7 SiO_{3/2}$, wherein each R^7 is a monovalent hydrocarbon radical having from one to forty carbon atoms; T' has the formula: $R^8 SiO_{3/2}$, wherein R^8 is a monovalent hydrocarbon radical having from one to forty carbon atoms; and Q has the formula: $SiO_{4/2}$.

29. The glass or plastic article of Claim 27, wherein the silicone compound is an ionic or nonionic siloxane alkoylate of the formula:



wherein each of R^{9-17} are independently a monovalent hydrocarbonyl radical, R^{18} is of the general formula: $R^{19}-Z-(C_mH_{(2m-1)}R^{20}O)_j(C_nH_{2n}O)_kR^{21}$, m and n are integers greater than or equal to 0; j and k are integers greater than or equal to 0, subject to the proviso that the sum of $j+k$ is greater than or equal to 1; Z is H, -O-, -S-, -SH-, -CO-, -NH-, or -NH₂-; R^{19} is a divalent hydrocarbylene radical, R^{20} and R^{21} are independently hydrogen, alkyl, hydroxyalkyl, amino, amido, aminoxide, cyano, isocyano, aryl, arylene, carboxy, alkoxy, halogen, haloalkyl, haloalkoxy, sulfo, sulfamo, phosphono, salts thereof, combinations comprising at least one of the foregoing, and the like; and wherein x and y are integers greater than or equal to 0, subject to the proviso that $x + y$ is greater than or equal to 1.

30. The glass or plastic article of Claim 27, wherein the polyol comprises a polycarbonate polyol.